MORNING SESSION

Intro (5 min)
Welcome, names, etc; show Galileo Thermometer heating up & Cartesian Diver, ask how do they work; say we're going to learn about the relationship between Pressure, Temperature, Forces in different kinds of materials in different conditions, by the end of the day you will be able to explain how these demonstrations work, build a diver to take home, and we'll all get to play with a real hover craft!

Kinematic Molecular Theory (15 min)
Brainstorm examples of gases, liquids, solids; what is a fluid? Make sure everyone is on the same page with vocabulary (condensation/evaporation, freezing/melting, sublimation/deposition). Properties of phases in containers, can you compress a gas? A liguid or a solid? Have students try to compress a full bottle of water, a bottle of air. "Kinematic molecular theory" http://www.youtube.com/watch?v=s-KvoVzukHo.

Liquid Nitrogen – Part 1 (5 min)
What is liquid N? (-196 deg C = 77 K) What phase change is it undergoing now (at room temp)? What will happen if I put a balloon over the top of this 2L bottle?...

Liquid Nitrogen – Part 2 (10 min)
What happens to a fluid when it is heated or cooled (but not to the point of phase change)? Pressure/Volume/Temperature relationship for gases. Ask a volunteer to blow up a balloon; what will happen if we get this very cold, by putting it in the liquid N?... what will happen when we take it out again?...

Liquid Nitrogen – Part 3
Use up N for fun! Break stuff!

Density (20 min)
What is density? Mass/Volume, V=Length*Height*Width. How can we measure density? Have all students measure density of some random object (weighing, submerging in water, using correct units).

Oil/Water/Alka-Seltzer Experiment (10 min)
What is denser: oil or water? Have each kid (or all together?) perform this experiment. What is happening? Gas/Water together are less dense than oil & rise, then the water alone sinks back down.

Galileo Thermometer (5 min)
Now can we explain how this works (in terms of temperature and fluid density)? When the bulb hovers between floating/sinking it is same density as the fluid.

Density of Water (20 min)
Using a cork and adding nails until it submerges, indirectly measure the density of water. Combination of denser & less dense materials can balance out to an in-between density.

Pressure & Force (20 min)
What is pressure? What is force? Brainstorm examples. Have students half-blow-up balloons and compress the air. What happens to the pressure? How can we explain this using kinematic molecular theory? Discuss squirt guns – how does the size of opening effect how far the water will go? Suppose you want to shoot spitballs – should you use a normal soda straw or a big bubble tea straw?

Balloon Rockets (10 min)
Compressed gas can do work. The increased pressure is a form of energy that can propel a rocket. Brainstorm examples of compressed air in every day life? Compare to a normal balloon (with bigger opening).

Potato Gun? (30 min +) or Water Gun?
Using compressed air to do work…

Hydraulics Demo (10 min?)
What happens to a liquid when you push on it? Pressure is transmitted throughout fluid (Pascal's Law). Contrast gas with liquid (compressibility). Examples in everyday life?

AFTERNOON SESSION

Pressure & Change of State (20 min)
Demonstrate that water can boil at a much lower temperature if the pressure is very low (100 deg C at STP).

Atmospheric Pressure (10 min)
Madeburg Hemispheres demo – pass around – what is causing the force? Analogy to force on your ears deep in a swimming pool; the weight of all the air above you. In which directions do you feel it? (all! compare to hydraulics demo).

Hoverboard (30 min)
Ask a volunteer to try hoverboard. How many people can we add and still have it hovering? P=F/A. Would a bigger or smaller surface work best? Calculate the force of the leaf blower by estimating the area, and mass of kids that can be added.

Bernoulli's Principle (30 min)
Pendulum swinging into the stream of water from faucet – what will happen when it touches the water? Try it. Have each kid tape paper to edge of desk and blow over it with straw. How might these observations be related? Flow (i.e. velocity) in a fluid reduces pressure around it. What will happen to two pop cans when you blow between them with a straw? Have a volunteer do it.

Airplane Wings (5 min)
How do airplanes fly? What are the forces acting on the plane? What does the wing look like.

Shop Vac Demo (10 min)
What are the forces acting on the ball? Gravity downwards, gas pressure upwards, atmospheric pressure against air stream keeps ball in place, even against gravity, somewhat.

Cartesian Divers (30 min)
Give out supplies and build. Can we explain how this works?

Extra Time? Play with Hoverboard, etc.